

**MOLDED DETERGENT COMPOSITION AND METHODS FOR
MANUFACTURING AND USING A MOLDED DETERGENT COMPOSITION**

Field of the Invention

5 The invention relates to molded detergent compositions and method for manufacturing and using a molded detergent composition.

Background of the Invention

Solid detergent compositions are described in the prior art. See U.S Patent Nos. RE 32,763 to Fernholtz, et al., RE 32,818 to Fernholtz, et al., 4,595,520 to Heile et al.; 4,680,134 to Heile et al.; 5,078,301 to Gladfelter et al.; and 5,080,819 to Morganson et al. The solid detergent compositions prepared according to these United States patents incorporate carbonate, caustic, silicate and other materials in combination with a variety of nonionic surfactants made using EO, PO, or EO and PO groups. In addition, see U.S. Patent Nos. 4,753,755 to Gansser; 4,931,202 to Cotter et al.; 5,482,641 to Fleisher; and 15 5,670,467 to Fleisher disclose the use of nonionic surfactants in solid detergents. Many of the processes described in the prior art require the use of heat in the formation of solid detergent blocks.

20 Solid detergent blocks are desirable because they generally require less shelf space than liquid detergents, they are generally easier to handle than liquid detergents, and they reduce the splashing hazard common to the use of liquid detergents.

Summary of the Invention

A method for manufacturing a molded detergent composition is provided by the invention. The method includes steps of mixing a hydrated component and a hydratable component to provide a mixture, and molding the mixture to provide a molded 25 detergent composition having a melting point greater than about 30° C. The hydrated component has a melting point below about 100° C and includes a transhydration product of an anhydrous material and water of hydration. The anhydrous material has a melting

point greater than about 300° C. The hydratable component comprises water, if present at all, at a level of less than about 2 wt.% based on the weight of the hydratable component. The hydratable component will successfully compete with the hydrated component for at least a portion of the water of hydration.

5 The hydrated component can include any material having a melting point below about 100°C which, when water is removed therefrom, has a melting point greater than about 300°C, and which surrenders water of hydration to the hydratable component. Preferably, the hydrated component is a material which surrenders water of hydration to the hydratable component under conditions of room temperature and atmosphere pressure
10 to a sufficient extent to provide the molded detergent composition with a melting point greater than about 30°C. The hydrated component preferably includes a hydrated salt. Exemplary hydrated salts include sodium silicate, lithium silicate, potassium silicate, sodium metasilicate, sodium phosphate, calcium phosphate, magnesium phosphate, sodium pyrophosphate, sodium tripolyphosphate, sodium sulfate, sodium carbonate,
15 sodium bicarbonate, sodium sesquicarbonate, sodium bisulfate, sodium thiosulfate, sodium perborate, and mixtures thereof.

20 The hydratable component can include any material having a water content of less than about 2 wt.% and which successfully competes with the hydrated component for at least a portion of the water of hydration. Preferably, the hydratable component successfully competes with the hydrated component for at least a portion of the water of hydration at room temperature and atmospheric pressure to an extent which provides the molded detergent composition with a melting point greater than about 30°C. The hydratable component is preferably a polar organic material. Preferred hydratable components include at least one of nonionic surfactants, anionic surfactants, glycol ethers, and mixture thereof.

25 The mixture can include additional components. Exemplary additional components include enzymes, solvents having high VOC content, dyes, fragrances, anti-redeposition agents, corrosion inhibitors, buffering agents, defoamers, anti-microbial agents, and preservatives.

The weight ratio of the hydrated component to the hydratable component is preferably between about 2:1 and about 20:1, and more preferably between about 3:1 and about 10:1. It should be understood that in determining this weight ratio, the weight of the hydrated component includes its water of hydration, and the weight of the 5 hydratable component includes its water of hydration if it includes any water of hydration. The weight ratio of the hydrated component to the hydratable component can be expressed on an anhydrous weight basis for each component. On an anhydrous weight basis for each component, a preferred weight ratio of hydrated component to hydratable component is between about 5:1 and about 20:1, and more preferably between about 1:8 10 and about 5:1.

A molded detergent composition is provided according to the invention. The molded detergent composition includes as a result of mixing and molding a composition including a hydrated component and a hydratable component.

Detailed Description of the Preferred Embodiment

15 A molded detergent composition according to the invention can be used in conventional solid detergent dispensing equipment. It should be understood that the phrase "molded detergent composition" describes compositions which have been molded to provide a particular shape and which are solid under conditions of room temperature and atmospheric pressure. The molded detergent according to the invention is preferably 20 provided in the form of blocks and/or pellets. Powder detergents and liquid detergents under conditions of room temperature and atmosphere pressure are not considered molded detergent compositions according to the invention. In contrast to blocks and pellets, powder detergents are generally available for use as detergents in a powdered state. That is, the powder detergents are generally provided as a mixture of granular dry 25 material. Powder detergents are often prepared by mixing dry materials or by mixing a slurry and drying the slurry. Pellets and blocks are typically provided with a size that is determined by the shape or configuration of the mold or extruder through which the detergent composition is compressed. Pellets generally can be characterized as having an average diameter of about 0.5 cm to about 2 cm. Blocks generally can be characterized

as having an average diameter of greater than about 2 cm. In general, blocks have an average diameter of between about 2 cm and about 2 ft, and, more preferably, between about 2 cm and about 1 ft.

The molded detergent composition according to the invention can be used
5 in conventional solid detergent dispensing equipment. Commercially available solid detergent dispensing equipment which can be used to process the molded detergent composition according to the invention are available under the name Solid System® from Ecolab Inc. In general, a detergent use solution is generated in this type of equipment as a result of erosion of the molded detergent composition by a water stream.

10 The molded detergent composition can be prepared by mixing a hydrated component and a hydratable component, and molding the mixture to provide a molded detergent composition having a melting point greater than about 30° C. The hydrated component is preferably a component having a melting point below about 100° C and can be characterized as a transhydration product of an anhydrous material and water of
15 hydration. Preferably, the anhydrous material has a melting point greater than about 300° C. It should be understood that there is no requirement that the hydrated component is to be prepared from an anhydrous material. Furthermore, it should be understood that the anhydrous material characterizes the hydrated component under a condition where water has been removed to an extent reasonable under normal processing conditions for the
20 removal of water. For example, if it is too difficult to remove all of the water, then the anhydrous material that characterizes the hydrated component can be considered as including water. When the anhydrous material is hydrated with water, the melting point decreases from greater than about 300° C for the anhydrous material to below about 100° C for the hydrated component. The hydratable component can be provided free of water,
25 although it is likely to include a small amount of water. If water is present in the hydratable component, it is preferably provided at a level of less than about 2 wt.% based on the weight of the hydratable component. More preferably, the amount of water provided in the hydratable component is less than about 1 wt.%, and even more preferably less than about 0.5 wt.%. The hydratable component can additionally be
30 characterized as a component which successfully competes with the hydrated component

for at least a portion of the water of hydration provided as part of the hydrated component. It is believed that the movement of the water of hydration from the hydrated component to the hydratable component provides for controlling the solidification of the mixture. That is, the rate of solidification of the mixture can be adjusted by controlling 5 the competitive hydration reaction.

The mixed composition can be shaped by conventional molding techniques including casting, compressing in a mold, and extruding. It is an advantage of the invention that the steps of mixing and molding can be practiced without a step of adding heat to the mixture. It is believed that during the mixing and molding steps, the 10 hydrated component and the hydratable component compete for the water of hydration. The hydratable component sufficiently hydrates to provide a solid detergent composition having a melting point of greater than about 30°C, and more preferably greater than about 50° C. Preferably, the melting point of the molded detergent composition according to the invention is sufficiently high so that the composition does not melt under conditions 15 commonly encountered in a warehouse. Typical warehouses often experience temperatures ranging between about 30°C and about 50°C.

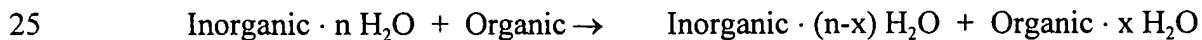
The hydrated component is preferably a material which has been at least partially hydrated. The hydrated material should contain a sufficient amount of the water of hydration so that at least a portion of the water of hydration will move to the 20 hydratable component. There is no requirement that the hydrated component must be fully hydrated. In addition, the hydrated component can be purchased in a hydrated state or it can be hydrated to obtain a target hydration level. The target hydration level is selected to provide the final composition with a melting point greater than about 30° C.

The hydratable component refers to a material which is substantially 25 anhydrous. By substantially anhydrous, it is meant that the component contains less than about 2 wt.% by weight water based upon the weight of the hydratable component. Preferably, the amount of water is less than about 1 wt.%, and more preferably less than about 0.5 wt.%. It should be understood that the reference to water includes water of hydration and free water. The phrase "water of hydration" refers to water which is 30 somehow attractively bound to a non-water molecule. An exemplary form of attraction

includes hydrogen bonding. There is no requirement that the hydratable component be completely anhydrous. The hydratable component can include water of hydration, but it should be appreciated that the hydratable component is provided for pulling water of hydration away from the hydrated component. Accordingly, although the hydratable 5 component need not be completely anhydrous, it should be sufficiently anhydrous so that it will successfully compete with the hydrated component for water of hydration.

It is believed that the level of hydration of the hydrated and hydratable components of the composition change during the solidification of the molded detergent compositions. That is, the hydrated component loses at least a portion of the water of 10 hydration, and the hydratable component gains water of hydration. Accordingly, it should be understood that the level of hydration of the materials in the molded detergent composition will be different from the level of hydration of the starting materials.

The hydrated component can include inorganic materials, and preferably includes at least one hydrated salt or a mixture of hydrated salts which, when combined 15 with the hydratable component, surrenders the water of hydration to the hydratable component. The hydratable component can include materials having an ability to hydrogen bond with water, and can successfully compete with the hydrated component for the water of hydration provided with the hydrated component. The hydratable component can include organic materials. The competition between the hydrated 20 component and the hydratable component for water of hydration can be expressed by the following formula where, in this instance, the hydrated component is characterized as an inorganic component, and the hydratable component is characterized as an organic material.



wherein, n is the moles of hydration provided with the hydrated material, and x is the moles of hydration which can be removed from the hydrated component. Preferably, n is between about 1 and about 12, more preferably between about 1 and about 6, and even

more preferably between about 2 and about 5. Preferably, x is between about 1 and about 12. It should be understood that x is equal to or less than n, and the resulting composition has a melting point of greater than about 30° C.

Exemplary salts which can be hydrated and used as the hydrated component according to the invention include sodium silicate, lithium silicate, potassium silicate, sodium metasilicate, sodium phosphate, calcium phosphate, magnesium phosphate, sodium pyrophosphate, sodium tripolyphosphate, sodium sulfate, sodium carbonate, sodium bicarbonate, sodium sesquicarbonate, sodium bisulfate, sodium thiosulfate, sodium perborate, and mixtures thereof.

The hydrated component can be purchased in the hydrated state, or can be hydrated by a pre-hydration step. In general, a material which is to be hydrated can be mixed with water under conditions which allow the water to become water of hydration. It is generally desirable to provide the hydrated component without free water. It should be understood that free water refers to water present with the hydrated component which is not water of hydration. The reason that free water is generally not desirable is that it is believed to compete with the water of hydration. That is, the hydratable component will likely hydrate using the free water prior to hydrating using the water of hydration. Of course, there may be circumstance in which it is desirable to include free water. For example, it is believed that the presence of free water will decrease the rate of solidification. Accordingly, if a composition including a hydrated component and a hydratable component solidifies too quickly, it may be advantageous to add an amount of free water to delay the competitive reaction for water of hydration.

The hydrated component is preferably provided from an anhydrous inorganic material having a melting point which is generally greater than about 300° C and more preferably greater than about 500° C. As the anhydrous inorganic material become hydrated, the melting point decreases. For a mono-hydrate of an inorganic material, the melting point is preferably below about 100° C.

The salts which can be hydrated and used as the hydrated component according to the invention generally exhibit a significantly higher melting point when anhydrous than when hydrated. For example, anhydrous sodium acetate has a melting

point of about 324° C. Sodium acetate hydrated with three moles of water has a melting point of about 58 ° C. Anhydrous sodium carbonate has a melting point of about 850° C, but sodium carbonate hydrated with one mole of water has a melting point of about 100° C and sodium carbonate hydrated with ten moles of water has a melting point of about 5 34° C. Anhydrous sodium phosphate has a melting point of about 1,340° C, but sodium phosphate hydrated with 12 moles of water has a melting point of about 73° C. Anhydrous sodium silicate has a melting point of about 1,089° C, and sodium silicate hydrated with about five moles of water has a melting point of about 72° C.

The hydratable component is a material which successfully competes with 10 the hydrated component for water of hydration. The hydratable component can be a polar organic component such as a nonionic surfactant, an anionic surfactant, or a mixture of nonionic surfactant and anionic surfactant. Exemplary nonionic surfactants include myristeth (7 EO), nonylphenol ethoxylate (9 EO), ethylene oxide polymers, propylene polymers, ethylene oxide/propylene oxide copolymers, decylpolyglycoside (DP 1.7), 15 laureth-9EObenzyl capped, and mixtures thereof. An exemplary anionic surfactant includes a sodium salt of dodecylbenzene sulfonic acid, sodium alpha-dodecenylo sulfonate, potassium salt of the sulfonated methyl ester of cocofatty acid, sodium tallow sulfonate, disodium decyldi(benzene sulfonate), ammonium lauryl ether sulfate, and magnesium tetradecyl sulfate.

20 The hydrated component and the hydratable component are preferably mixed at a weight ratio which results in the formation of a solid composition having a melting point which is greater than about 30°C. It is generally desirable to provide a sufficient amount of the hydrated component so that, when it loses its water of hydration, there is enough of the material to provide the solid composition with a melting point 25 greater than about 30° C. As discussed previously, as the hydrated component loses its water of hydration, the melting point of the material increases. When the hydrated component loses all of its water of hydration, it is an anhydrous material having a melting point of greater than 300° C, and more preferably greater than about 500° C. In order to provide the resulting molded composition with a melting point greater than about 30° C, 30 it is preferable to provide an amount of the hydrated component which corresponds to an

amount its anhydrous material in the molded composition of at least about 40 wt.% based upon the weight of the molded material. In addition, it is preferable to provide an amount of the hydrated component which corresponds to an amount of the anhydrous component in the molded composition which is less than about 90 wt.% based on the weight of the 5 molded composition. Preferably, the amount of hydrated component is provided so that the molded composition contains between about 50 wt.% and about 80 wt.% of its anhydrous material based on the weight of the molded composition.

The amount of the hydrated component is expressed in terms of the amount of its anhydrous material. This is because the amount of water of hydration can 10 vary significantly thereby effecting the actual weight percent value of the hydrated component. Furthermore, it is believed that it is the interaction between the hydrated material and the hydratable material which results in the solidification of the molded composition. It is believed that the structure of the molded composition can be 15 theoretically modeled by comparison to a matrix structure being held in place by glue. In this model, the hydrated material forms the matrix, and the hydratable component acts as the glue. If there is too little glue, the matrix component is not held together. If there is 20 too much glue, the resulting composition is too mushy to be considered a solid composition. Preferably, the weight ratio of hydrated component to hydratable component, on a dry basis (free of water of hydration) is between about 5:1 and about 20:1, and more preferably between about 8:1 and about 15:1.

The melting point of the molded detergent composition can vary depending upon the technique used to mold the composition. When casting to provide a molded detergent composition, it is desirable to provide a melting point of between about 25 30° C and about 50° C. When extruding to provide a molded detergent composition, it is generally desirable to provide a melting point of between about 50° C and about 100° C. In general, when molding by casting, it is generally desirable to handle a composition 30 which is relatively soft. In contrast, when molding by extruding under high pressure and temperature, it is desirable for the composition to be less soft.

The selection of the hydrated component and the hydratable component and the ratio of the components is, at least in part, determined by the length of time it

takes to solidify the composition. If the composition solidifies too quickly, there may not be enough time to provide the composition in a desired molded shape. In addition, if the solidification proceeds too slowly, it may become too costly to wait for the solidification to occur. In the case of molding by extrusion, it is generally desirable for the 5 solidification to take between about 1 minute and about 15 minutes, and more preferably between about 5 minutes and about 10 minutes. When casting, it is generally desirable to provide the solidification at a time of between about 15 minutes and about 30 minutes.

A solid detergent composition according to the invention can include additional components. The composition preferably includes a sufficient amount of the 10 hydrated component and hydratable component to provide a detergent composition having a melting point of greater than about 30°C. Preferably, the detergent composition includes at least about 50 wt. % of the combined hydrated component and the hydratable component. More preferably, the detergent composition includes at least about 75 wt. % of the combined hydrated component and the hydratable component.

15 Additional components which can be incorporated into the solid detergent composition include enzymes, solvents having high VOC content, dyes, fragrances, anti-redeposition agents, corrosion inhibitors, buffering agents, defoamers, antimicrobial agents, and preservatives. It is expected that certain of these components can be provided so that they participate in the hydration competition. That is, certain of these components 20 can be considered either hydrated components or hydratable components depending upon whether they enter into the hydration competition and whether they surrender water of hydration or gain water of hydration. Of course, it is not necessary for any of the additional components to enter into the hydration competition.

The molded detergent composition according to the invention can include 25 enzymes. In general, prior art molded detergent compositions that rely upon heat as a step in the solidification process do not include enzymes because enzymes tend to become denatured by the application of heat. According to the invention, enzymes can be incorporated into the molded detergent composition because the molded detergent composition can be prepared without the addition of heat. Exemplary types of enzymes 30 which can be incorporated into the molded detergent composition include protease,

lipase, amylase, cellulase, and mixtures thereof. In particular, it is an advantage of the invention that the molded detergent composition can include a mixture of protease with at least one of lipase, amylase, and cellulase. Because the molded detergent composition is provided in a solid form, the protease will be precluded from attacking other enzymes

5 until the detergent composition is liquefied. An exemplary protease which can be included in the molded detergent composition according to the invention is available under the name Purafect 4000L from Genecor. An exemplary lipase which can be incorporated into the molded detergent composition of the invention is available under the name Lipolase 100T from Novo Nordisk. An exemplary amylase which can be

10 incorporated into the molded detergent composition of the invention is available under the name Maxamyl WL15,000 from Gist-Brocades. An exemplary cellulase which can be incorporated into the molded detergent composition of the invention is available under the name Celluzyme 0.7T from Novo Nordisk.

The enzymes are preferably incorporated into the molded detergent composition in an amount which is useful for cleaning applications. In general, the amount of enzyme incorporated is controlled by the cost of the enzyme. In general, it is desirable to provide the molded detergent composition with a total enzyme content of between about 0.01 wt.% and about 10 wt.% based upon the weight of the molded detergent composition, and preferably between about 0.1 wt.% and about 5 wt.%, and

15 more preferably between about 0.5 wt.% and about 2 wt.%.

Additional components which can be incorporated into the molded detergent composition and which are sensitive to heat include fragrances, dyes, preservatives, and anti-microbial agents. It is an advantage of the invention that temperature sensitive materials can be incorporated into the molded composition. A preferred anti-microbial agent which can be incorporated into the molded detergent composition includes paraben materials such as propyl paraben. In general, paraben materials tend to decompose at elevated temperatures.

Exemplary anti-redeposition agents which can be incorporated into the molded composition include sodium carboxy methylcellulose, sodium polyacrylate, and

30 hydroxypropyl cellulose. Exemplary corrosion inhibitors which can be incorporated into

the molded composition include triethanolamine, and dodanylamine. Exemplary buffering agents which can be incorporated into the molded composition include sodium acetate, potassium dihydrogen phosphate, and sodium borate. Exemplary defoamers which can be incorporated into the molded composition include polymeric silicone derivatives, and alkynol derivatives. Exemplary antimicrobial agents which can be incorporated into the molded composition include tert-amylphenol, quaternary ammonium compounds, and active halogen containing compounds. Exemplary aesthetic additives which can be used include dyes and fragrances. A preferred dye includes dye #2, and a preferred fragrance includes lemon fragrance.

10 The invention can be used to contain solvent materials commonly used in the cleaning industry in a solid form. Many of the solvents are considered low VOC content solvents. By low VOC, it is meant that it contributes to air pollution by the Environmental Protection Agency's VOC regulated limits. According to the invention, these types of materials can be incorporated into the detergent composition and contained 15 in such a way that the volatile organic compound level of the molded detergent composition is relatively low. A solvent which is commonly used in the cleaning industry and which is considered to have a relatively low volatile organic compound content is butoxy ethanol. Butoxy ethanol is commonly available under the name Butyl Cellusolve from Union Carbide.

20 The molded detergent composition according to the invention is particularly useful for warewashing applications and laundry applications. It should be understood, however, that the molded detergent composition can be used for laundry washing applications, carpet cleaning applications, and hard surface cleaning applications. Machines useful for using the molded detergent composition according to 25 the invention are commercially available. Dispensers can be provided for using the molded detergent composition for cleaning carpets and hard surfaces.

Example 1

Twenty eight detergent compositions were prepared, and the melting point of each composition was measured. The starting material for each composition is 30 reported in Table 1 and the amount of each component is expressed as a weight percent of

starting material based upon the total weight of the composition. Each composition was prepared by pre-hydrating the inorganic material with the amount of water indicated. The compositions were mixed together and allowed to stand in a mold. The compositions were initially very soft (exhibiting a melting point near room temperature), but hardened over time. The initial compositions could be characterized as soft solids or pastes. The melting points reported in Table 1 were measured after the compositions were allowed to harden. The melting points were determined after the compositions were observed to have finished hardening.

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Table 1

Component	1	2	3	4	5	6	7	8	9	10	11	12	13	14
sodium tripolyphosphate ¹	23.8	22.7	20.0	15.0	25.0	25.0	40.0	19.0	21.5	20.0	25.0	20.0	19.0	
sodium metasilicate ²	47.6	45.5	50.0	50.0	50.0	45.0	40.0	36.0	38.5	40.0	30.0	40.0	36.0	
sodium carbonate ³	0	0	0	0	0	0	0	0	0	0	0	0	0	
NPE-9.5 ⁴	0	0	5.0	10.0	5.0	10.0	5.0	10.0	10.0	10.0	10.0	10.0	20.0	0
NPE-4.5 ⁵	0	0	0	0	0	0	0	0	0	0	0	0	0	10.0
NPE-12 ⁶	0	0	0	0	0	0	0	0	0	0	0	0	0	0
laureth-myristeth-7 EO ⁷	4.8	9.1	0	0	0	0	0	0	0	0	0	0	0	0
LF-40 (EO/PO) ⁸	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LF-62 (EO/PO) ⁹	0	0	0	0	0	0	0	0	0	0	0	0	0	0
sodium dodecylbenzene sulfonate ¹⁰	0	0	0	0	0	0	0	0	0	0	0	0	0	0
water	23.8	22.7	25.0	22.7	20.0	15.0	25.0	35.0	30.0	30.0	35.0	20.0	35.0	
mp (C)	50.0	50.0	70.0	30.0	70.0	90.0	70.0	50.0	45.0	60.0	70.0	70.0	wet	70.0

Table 1 (Continued)

Component	15	16	17	18	19	20	21	22	23	24	25	26	27	28
sodium tripolyphosphate	19.0	19.0	19.0	19.0	19.0	21.5	16.5	21.5	21.5	16.5	22.0	15.0	27.7	
sodium metasilicate	36.0	36.0	36.0	36.0	36.0	38.5	33.5	38.5	38.5	33.5	59.0	35.8	24.5	
sodium carbonate	0	0	0	0	0	0	0	0	0	0	0	0	0	
NPE-9.5	0	0	0	0	0	0	0	0	0	0	0	0	0	
NPE-4.5	0	0	0	0	0	10.0	0	0	0	0	0	0	0	
NPE-12	10.0	0	0	0	0	10.0	0	0	0	0	0	0	0	
laureth-myristeth-7 EO	0	10.0	0	0	0	0	20.0	0	0	0	0	0	0	
LF-40 (EO/PO)	0	0	10.0	0	0	0	0	20.0	0	0	0	0	0	
LF-62 (EO/PO)	0	0	0	10.0	0	0	0	0	10.0	10.0	0	0	0	
sodium dodecylbenzene sulfonate	0	0	0	10.0	0	0	0	0	0	0	3.0	3.2	3.2	
water	35.0	35.0	35.0	35.0	30.0	40.0	20.0	20.0	30.0	40.0	5.0	34.4	33.0	
mp (C)	70.0	65.0	65.0	65.0	soft	50.0	wet	wet	70.0	soft	60.0	70.0	75.0	

¹ Sodium tripolyphosphate has a melting point greater than 500° C.² Sodium metasilicate has a melting point greater than 500° C.³ Sodium carbonate has a melting point greater than 500° C.⁴ NPE-9.5 is nonylphenol ethoxylate having an average of nine ethylene oxide units, and is provided as a liquid at room temperature, and is available from Huntsman Chemical.⁵ NPE-4.5 is nonylphenol ethoxylate having an average of 4.5 ethylene oxide units per molecule, and is a liquid at room temperature, and is available from Huntsman Chemical.⁶ NPE-12 is nonylphenol ethoxylate having an average of 12 ethylene oxide groups per molecule and is available as a liquid at room temperature, and is available from Huntsman Chemical.⁷ Laureth-myristeth-7 EO is an aliphatic ethoxylate available under the name Surfonic L24-7 from Huntsman Chemical.⁸ LF-40 (EO/PO) is an ethylene oxide/propylene oxide copolymer, and is available as a liquid at room temperature, and is available from⁹ LF-62 (EO/PO) is an ethylene oxide/propylene oxide copolymer, and is available as a liquid at room temperature, and is available from¹⁰ Sodium dodecylbenzene sulfonate is available as a liquid at room temperature.

It is believed that sample composition numbers 13, 19, 21-23, and 25 include too much water for the surfactant to handle.

The above discussion, examples and data provide a basis for understanding the disclosure. However, the invention can embody a variety of 5 compositions and methods. The invention accordingly is found in the claims hereinafter appended.

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